Double Orange.

THE abnormality in a Maltese orange described in NATURE of April 7 (p. 534) would appear of common occurrence in the Queensland or South Australian fruit. A friend assures me that in a case recently received from Australia, 80 per cent. of the contents showed small oranges, more or less perfect, either embedded in the pulp or in the rind. The quality of the fruit I observed was in no way affected. It would, however, be interesting to obtain further testimony. Although the small oranges may not affect the commercial value of the fruit, their presence must be undesirable in the groves where perfection is sought.

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ON THE LINE SPECTRA OF THE ELEMENTS.

THE distribution of the lines in the spectra of the elements is by no means so irregular as it might seem at first sight. Since Lecoq de Boisbaudran, in 1869, discovered the general plan in the spectra of the alkali metals, a number of interesting facts have been brought to light, which will probably one of these days find their mechanical explanation, and will then greatly advance our knowledge of the molecules.

Mechanical explanations of some of the facts have been attempted already. Lecoq de Boisbaudran explains the fact that the rays of the alkali metals are, on the whole, less refrangible the greater the atomic weight, by observing that the oscillations of a body suspended in a given elastic medium will become less frequent when the mass of the body is increased. This explanation, however, seems to me to remain rather vague and unsatisfactory as long as it does not lead to any numerical results that agree with the observations. Taken literally, it makes the oscillation-frequency inversely proportional to the square root of the atomic weight, which is far from being the case.

A second well-established fact has received different explanations by Julius[1] and by Johnstone Stoney.[2] It has long been observed by Hartley that in the spectrum of several elements a number of doublets or triplets of lines appear, the oscillation-frequencies in each doublet or triplet differing by the same amount. Recent measurements by Prof. Kayser and myself have confirmed this observation. Julius believes that this phenomenon is due to a cause analogous to the combination tones in the theory of sound.

If two rays, with oscillation-frequencies α, β, combine with other rays, p, q, r, s, to oscillation-frequencies

$$\begin{array}{cccc} p + \alpha & q + \alpha & r + \alpha & + \alpha \\ p + \beta & q + \beta & r + \beta & s + \beta, \end{array}$$

the same difference $\alpha - \beta$ will occur several times. That the doublets under consideration are in many cases remarkably strong is accounted for by the fact that the intensity of the combination tone is proportional to the product of the intensities of the primary tones, so that it must become very strong when the amplitude of the primary tones is sufficiently increased.

Johnstone Stoney gives a different explanation of the doublets. He supposes that the path of the molecule from which light emanates is an ellipse, which by disturbing forces is gradually changed, and he shows that on this supposition, instead of one ray, two rays or more would originate, and the oscillation-frequencies of these rays would differ by an amount depending on the rate of change of the ellipse. If now, instead of the ellipse, the path of the molecule is any other curve, it can be considered as consisting of a number of superposed ellipses, all of which change in the same way on account of the disturbing forces. To each of the ellipses a doublet of lines corresponds, and the oscillation-frequencies of each doublet differ by the same amount. In this explanation I do not understand the decomposition of the arbitrary curve in a series of superposed ellipses. For the movement is supposed not to be periodical, and Fourier's theorem then would not apply, at least the periods of the superposed ellipses would not be definite, as long as there are no data except the arbitrary curve itself.

Besides, both Johnstone Stoney and Julius only try to explain one of a number of regularities that have been observed in the spectra of the elements. A plausible suggestion about the movement of the molecules ought to explain more than one of the observed phenomena. I think it may be useful to point out the other regularities that have been observed in the distribution of lines, and for which as yet no mechanical explanation has been attempted.

(1) The doublets and triplets existing in the spectrum of an element can be arranged in series which show an appearance of great regularity. These series seem to be analogous to the over-tones of a vibrating body. But they possess a remarkable peculiarity, which, as far as I know, is without analogy in the theory of sound. The difference of two consecutive oscillation-frequencies decreases as these increase, and there seems to exist a finite limit to the oscillation-frequencies of a series. If n represents integer numbers, the oscillation-frequencies of a series may with great accuracy be represented by the formula—

$$A - Bn^{-2} - Cn^{-4},$$

where A, B, C are positive constants. B has nearly the same value for all the series of the different spectra. A is the limit towards which the oscillation-frequency tends, when n increases.

(2) For elements that are chemically related, the series are distinctly homologous, both in appearance of the lines and in the values of A, B, C, and with increasing atomic weight shift towards the less refrangible end of the spectrum. Homologous series have been observed in the following groups of elements :—

Lithium, sodium, potassium, rubidium, cæsium ;
Copper, silver ;
Magnesium, calcium, strontium ;
Zinc, cadmium, mercury ;
Aluminium, indium, thallium.

In the first two and in the last group the series consist of doublets,[1] while in the remaining two groups they consist of triplets. Thus we may say that the spectrum shows a relationship between the elements similar to that between their chemical properties. It is interesting to note that magnesium forms a group with calcium and strontium, and appears more nearly related to them than to zinc, cadmium, and mercury.

(3) The doublets and triplets in each group broaden as the atomic weight increases. In the first group the difference of oscillation-frequencies is nearly proportional to the square of the atomic weight. The constant difference of the oscillation-frequencies in the doublets and triplets may also be noted in the values of A, B, C. For a series of doublets or triplets we have two or three different values of A, but only one value of B and one value of C.

(4) In each of the spectra of sodium, potassium, rubidium, and cæsium, a series of doublets has been observed, in which the oscillation-frequencies do not differ by a constant amount, the difference diminishing inversely proportional to n^4. For these series A and B have only one value each. The least refrangible doublet of the series has the same difference of oscillation-frequencies as the doublets in the other series of the same element. In the spectrum of lithium there is a homologous series of single lines. All the lines of these series have the same

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[1] Julius, *Annales de l'École Polytechnique de Delft*, tome v. (1889).

[2] Stoney, Trans. of the Roy. Dublin Soc., vol. iv. (1891).

[1] Lithium has here to be excepted, whose lines are all single.

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character; they are strong and easily reversed, and in all of them the first doublet is situated on the less refrangible side of the spectrum, and all the others in the violet and ultra-violet. The series shift towards the less refrangible side with increasing atomic weight.

For further details the reader is referred to the following memoirs:—Kayser and Runge, "Ueber die Spectren der Elemente," *Abhandl. der Berl. Akademie*, 1890-92; Rydberg, "Recherches sur la constitution des spectres d'émission des élements chimiques," *Kongl. Svenska Vetenskaps-Akademiens Handlingar*, Bandet 23, No. 11, 1890. C. RUNGE.

ABERRANT FOSSIL UNGULATES OF SOUTH AMERICA.

TILL within the last few years palæontologists and zoologists were being continually startled by the discovery of strange forms of extinct Ungulates which rewarded the researches conducted in the Tertiary rocks of the United States. The animals thus brought to the notice of the scientific world have, to a very large extent, modified our conceptions of the relationships of the various groups of hoofed or Ungulate Mammals to one another; and have led to the very general adoption of the view of the ordinal unity of all these multifarious types. Several of them, indeed, so far as we may judge from their mere skeletons, indicate signs of a transition between the Perissodactyle and Proboscidean modifications of Ungulate structure; but none of them tend in the least degree to break down the hard and fast line of demarcation between the Perissodactyle (odd-toed) and Artiodactyle (even-toed) modifications, which is maintained throughout all the known Tertiary deposits of the Old World. Moreover, after a little "shaking down," the whole of these North American Ungulates, with the exception of the curious Rodent-like *Tillotherium*, fall fairly well into their places in the Ungulate order; although some of the earlier and smaller types present indications of close affinity with the common stock from which we may presume both Ungulates and Carnivores to have taken origin.

At the present time the wave of discovery of new forms appears to be passing from the northern to the southern half of the New World; so that while the palæontologists of the United States are to a great extent engaged in the important task of revising and completing the preliminary work of the last twenty years, their *confrères* in Argentina are almost flooding scientific literature with descriptions—sometimes, it is to be feared, rather crude and hasty ones—of a number of new or hitherto imperfectly known forms of extinct mammals. This descriptive work has been mainly undertaken by Messrs. Ameghino, Burmeister, and Moreno. Unfortunately, however, the greater part of it is still in the form of preliminary notices, unaccompanied by illustrations; while on several points the three describers above mentioned are by no means in accord, and it is quite clear that unnecessary names have frequently been published. There is, indeed, one large illustrated work published by Dr. Ameghino; but since, so far as we are aware, there is only a single copy (in the Natural History Museum) in England, palæontologists have not the opportunity of paying it that attention in private study which its importance demands.

In spite, however, of these drawbacks, the information at present before us—imperfect though it be—introduces us to several groups of extinct Ungulates totally unlike any found in all the rest of the world put together, and which are of especial interest as tending to a certain extent to break down the distinction between Perissodactyles and Artiodactyles. It should be observed, before proceeding further, that the explorations conducted in Patagonia and various parts of Argentina have shown that the deposits containing mammalian remains, instead of being exclusively of Pleistocene age, comprise a large portion of the Tertiary period, probably extending down at least as far as the Oligocene; although the exact correlation of the different beds with European deposits is probably premature.

With these preliminary observations, and asking our readers at the same time to bear in mind that a considerable part of our knowledge is still in a very imperfect and crude condition, we propose to glance at some of the peculiarities presented by the more remarkable forms of Ungulates described from the deposits in question.

Since the date of the publication of the results of Darwin's voyage in the *Beagle*, we have been gradually acquiring a knowledge of the structure of that remarkable South American Ungulate known as *Macrauchenia*, of which the complete osteology has been described by Burmeister. This animal, which had the general proportions and size of a horse, conforms in several respects—more especially in having three-toed feet, in which the middle (third) digit is symmetrical in itself—so markedly with the Perissodactyles, that by common consent it has been generally regarded as an extremely aberrant member of that group. The molar teeth are, indeed, more like those of the Rhinoceros and Palæotherium than of any other Old World Ungulates, while the infolding of the enamel of the crowns of the incisors is a character known elsewhere only in the horses. The absence of any gap in the dental series, and the nearly even height of the teeth, are characters in which *Macrauchenia* agrees with the Old World *Anoplotherium*. Perissodactyle affinities are indicated by the presence of a third trochanter on the femur; but in certain peculiarities in the ankle-joint this animal differs from all typical Perissodactyles, and agrees with the Artiodactyles. Moreover, a certain peculiarity of structure in the vertebræ of the neck is repeated elsewhere only in the camels and llamas, which form an isolated group of Artiodactyles. In the complete closure of the orbit by bone, *Macrauchenia* resembles the horses and many Artiodactyles; but in the narial aperture being situated on the top of the skull between the orbits (whence the nostrils were probably produced in the form of a proboscis), it is absolutely peculiar.

There are thus many indications that, while *Macrauchenia* is a specialized form that can in no sense be regarded as the ancestral type from which Perissodactyles and Artiodactyles have originated, it retains certain generalized features which were probably directly derived from such ancestral stock.

Among the Ungulates discovered in Patagonia is one named *Proterotherium*, which was at one time referred to the Artiodactyles, but subsequently placed among the Perissodactyles. In the skull, so far as can be gathered from Ameghino's description, the orbit is closed, as in *Macrauchenia*, but the narial aperture appears to have had the normal position. The molar teeth are so like those of true Perissodactyles that they were originally described under the name of *Anchitherium*; but the rest of the dentition is very peculiar. Thus, in the upper jaw there appears to have been only a single pair of incisors in the premaxillæ, these being pyramidal and obliquely truncated like the canines of the pigs; and as there were no canines, it may be inferred that there was a long toothless interval in the jaw. In the lower jaw there were two pairs of incisors, and no canines. The lower molar teeth were inserted by four distinct roots—a feature unknown in any existing Perissodactyle, although occurring in the pig. In the limbs, both the front and hind feet were furnished with three complete toes, much resembling those of *Hipparion*; the ankle-joint is, however, said to resemble that of the Artiodactyles. We have no information as to the third trochanter of the femur. On the whole, this genus appears to indicate a

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